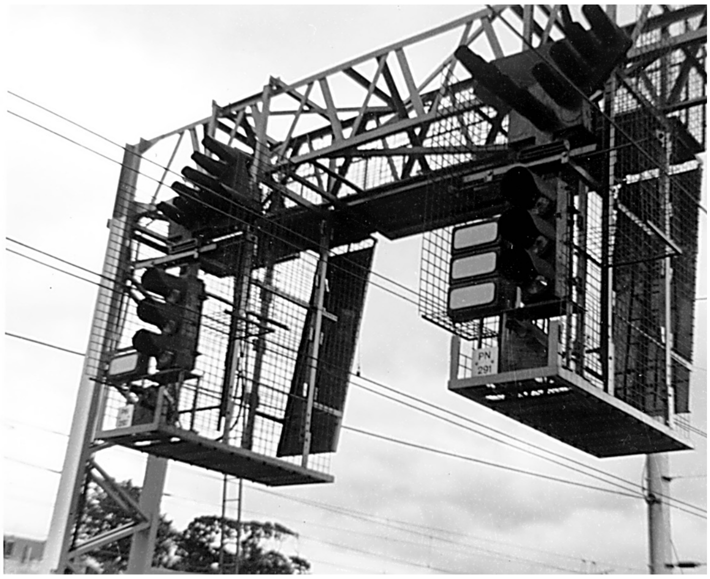
Signalling A Brighter Future



Rodger Bradley

Perhaps there is really no bright future for lineside signals at least, as the man-machine interaction from the driving cab is supplemented, and eventually replaced by the computer-machine interaction. In the UK, as nowhere else in Europe does the function of the signalling system occupy as much space in the consciousness of the travelling public – it has always occupied the highest priority in the industry. The traditional fixed block signalling technology is being replaced by moving block, with one of the largest projects for the new Europe wide ERTMS/ETCS systems to be deployed in Britain. There are pockets of variations of this technology in place around Europe, providing improved train control, closer headways between trains, in turn leading to business benefits to the train operator. In the UK, until the deployment of the TPWS – a halfway house to full ATP – the only step change in signalling technology was delivered with the completion of the Channel Tunnel and the use of signalling systems used in France.

Interlocking & Automatic Train Protection

Control of train movements through mechanical and electro-mechanical means has been replaced by SSI (Solid State Interlocking) and IECC's (Integrated Electronic Control Centres), but still has the track divided up into sections that may only be occupied by one train at a time. Ensuring this happens is the responsibility of the signalling system, with location of trains determined by track circuits, fed back to control centres that provide authority to the train crew to proceed, or stop. This is being replaced by moving block signalling, where the fixed sections of track are replaced by a combination of lineside and train mounted equipment, providing positive indication of train locations and transmitting instructions directly to the train and crew. The new electronic interlocking systems are required to have the highest reliability and availability, with the status of inputs from command and control signals compared across multiple redundant processors, before carrying out any instruction, and cover three main areas:

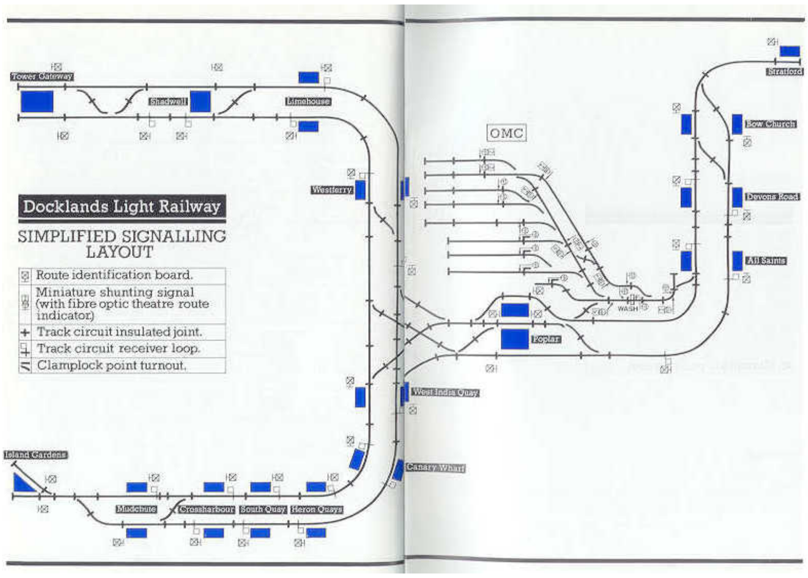
- The combination of hardware and software to maintain the logic for safe operation of trains - the control centre equipment.
- The medium - copper or fibre-optic cable - connecting the train control centre equipment to the trackside equipment.
- The interface between the trackside and control centre based equipment.

The input logic can take the profile of the route section, yard or station layout, to generate interlocking programs, or convert interlocking rules for the route into logical expressions within computer programs to work the interlocking.

Examples of these SSIs used in the UK and Europe include:

- ALCATEL ELEKTRA & ESTW L90
- ALSTOM SSI/ PLP/ PAI
- ALSTOM Smartlock, VPI (Vital Processor Interlocking), FELB
- Ansaldo ACC
- Bombardier (Adtranz) EBILOCK
- Siemens SIMIS
- Westinghouse SSI, Westrace

In the UK, all the European makers have systems interlocking systems installed, providing the vital control and coordination of signals and point/switch machines for train routing in simple and complex locations. But, with the move towards moving block systems, do interlocking systems have a future?

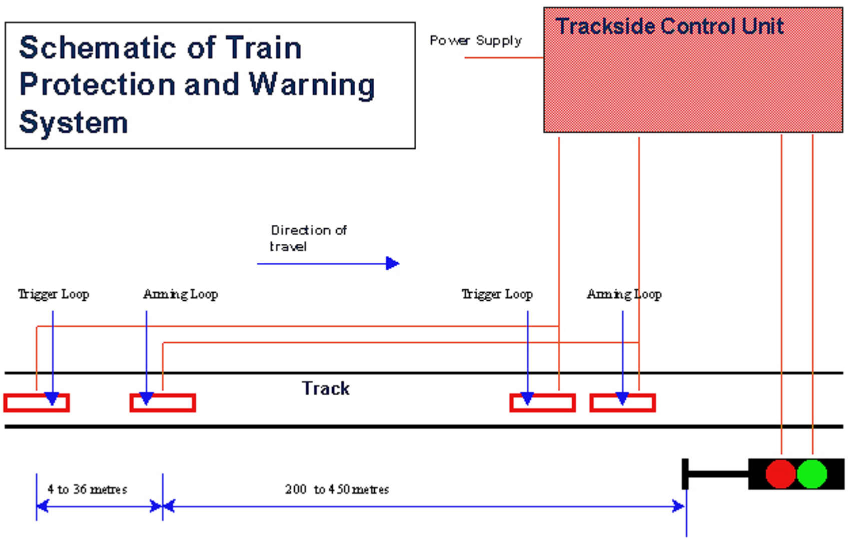


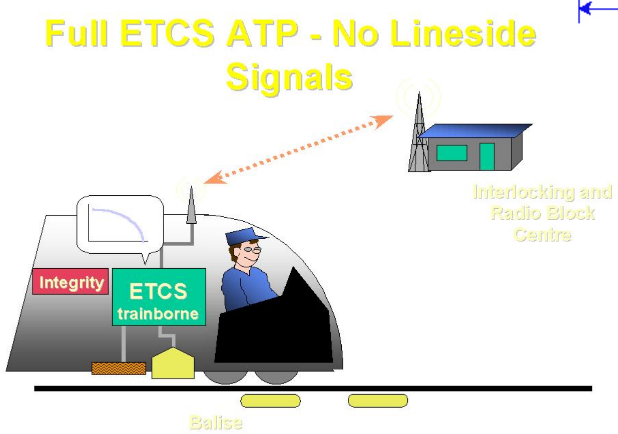
In addition, sophisticated ATP (Automatic Train Protection), automatic overrun and speed protection, control and operation functions and wayside transponder-based systems are designed and delivered by Alcatel, Siemens, Bombardier, Alstom and Westinghouse. An early example of modern ATP was introduced on the Docklands Light Railway in the mid-1980s as part of the railway's fully automatic train control (ATC) technology, based on Alcatel's "Seltrac" system, providing the UK's first example of the use of "moving block signalling". The ATP component uses jointless track circuits, also used on the main line railway, that positively and continuously detect the position and speed of a train. The train's on-board computer receives and transmits data to a central Control centre by means of antenna carried on the vehicle, which is continuously compared with timetable information, including safe operating speed and headways between trains.

In the rest of Europe, disparate ATP systems have been around for a few years, including Deutsche Bundesbahn's LZB, TVM in France (a version of TVM3 & 4 was adopted in the Channel Tunnel), along with new train control systems for Italy and Denmark

ERTMS/ETCS & TPWS – Train Control and Monitoring Systems

TPWS (Train Protection & Warning System) is being introduced in the UK, in the wake of the Southall tragedy in order to improve train protection, incorporating existing warning systems, and is a stepping stone towards a full ATP platform. Two pairs of loops, placed between the running rails acting as transmission beacons can initiate emergency braking to halt the train if it is either about to pass a red signal or has exceeded a maximum permitted speed by





more than a set margin. TPWS has been designed to be simple to fit to existing track and trains, and unlike existing warning systems, cannot be overridden by the driver. The new ETCS platform, like previous Automatic Train Protection (ATP) systems, has two main aspects - trackside systems and the train borne equipment. Three major sub-components covering the track based equipment (Eurobalise), GSM radio communications (Euroradio) and vehicle/cab mounted equipment (Eurocab) comprise ETCS. ETCS with its principal sub-components is modular and allows the national railway systems to implement interoperability in a phased manner, incorporating existing systems.

The new ETCS platform uses a magnetic transponder positioned between the running rails, and inductive coupling transmits energy from the train to the balise, and exchanges information in both directions. The train carries the antenna, which transmits a carrier at 27.115MHz, to power up the balise, which does not need a separate power supply. The principal suppliers of the ETCS and indeed, in the UK's TPWS system, include Bombardier, Alcatel, and Alstom, with Bombardier (as Adtranz) responsible for the design of the track-mounted balises. Alstom's TCS (Train Control System) for Railtrack's West Coast Upgrade, was designed to provide Level 2 ETCS, in the largest such project in Europe. Both Level 2 and Level 3 of ETCS depend on the adoption and use of the "Euroradio" platform, to transmit driving authority and signal position details to the train, and in turn, details of train speed and location are passed back to the control centre.

On the trains themselves, the on-board communications network (TCN is now IEC standard 61375-1) although other on-train bus protocols such as FIP are already in use. Alstom built "METROPOLIS" multiple unit platform features the use of integral WorldFIP networks in Alstom's "AGATE" product, delivering information and managing the train's performance. An interesting recent development from EKE, is the Trainnet® Gateway that provides TCN-based data communication between a range of on-train bus lines. The architecture of this modular product is sufficiently versatile to allow simultaneous connections between several bus lines, with the train management system providing monitoring and control of all vehicle sub-systems, supporting train crews and maintenance staff. Based around the TCN network standard, the system can be installed in new trains or used to augment existing equipment, and includes event loggers and data recorders, with the capability to reliably support large volumes of data and registration of multiple protocols. Elements of the product set perform like an aircraft's flight recorder, ensuring that important train data can be preserved even under demanding operating conditions.

Communications Services

Improvements in track to train communications have been a driving force behind the success of transmission based signalling systems. The new digital radio communications – TETRA – is being adopted in many areas, together with the use of "leaky feeder" co-axial cables laid along the tracks, to provide a means of delivering and receiving data from and to the trains. Such platforms are being used by London Underground as part of the "Connect" project, which also includes the provision of fibre-optic communications links, and ATM/SDH services, for high-speed information transfer.

Another interesting innovation, using radio communications will allow normal telephony subscribers to connect to a rail vehicle. This is a new development in the ongoing merger of voice and data communications, transferring voice signals over the rail operator's data network, using voice over IP (VoIP) technology. In addition to the general public to call passengers on trains and public transport, the wider use of VoIP will reduce both telephony and data communications operating costs, removing the need for separate communications links at many workplaces.

Use of GPS systems for vehicle and train location is not new, but not common in Europe, where distances and locations are not so great, or isolated as, say in Asia, national rail networks have devised their own train positioning systems. Where changes have been made, and are developing, is in the use of mobile radio and the new "Euroradio" platforms, being implemented for ERTMS/ETCS. Euroradio uses the specific GSM-R mobile communications standard, with Nortel Networks GmbH supplying the entire radio network and infrastructure for the first commercial GSM-R network in Europe. Siemens Transportation Systems have implemented this on the new ICE high-speed route operated by Deutsche Bahn AG between Frankfurt/Main and Cologne.

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